Announcements

- Homework for tomorrow…

  Ch. 32: CQ 9, Probs. 26, 28, & 34

  32.10: 750 A

  32.13: @ a & c: (2.0 x 10^{-4} T) ihat, @ b: (2.0 x 10^{-4} T) ihat

  32.14: @ a & c: (6.7 x 10^{-5} T) khat, @ b: -(2.0 x 10^{-5} T) khat

- Office hours…

  MW 10-11 am

  TR 9-10 am

  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm

  F 8-11 am, 2-5 pm

  Su 1-5 pm

Chapter 32

The Magnetic Field

(*The Magnetic Force on a Moving Charge & on a Current-Carrying Wire*)

Review…

The *B*-field (on axis) of a *current loop* of radius *R* carrying a current *I*, when *z* >>*R*…

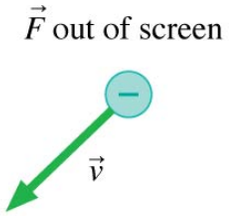
$$\vec{B}_{dipole} = \frac{\mu_0}{4\pi}\frac{2\vec{\mu}}{z^3}$$

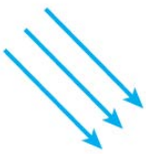
Force on a charged particle with a velocity *v* in a *B*-field …

$$\vec{F}_{on\ q} = q\vec{v} \times \vec{B}$$

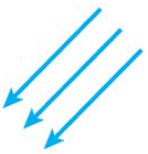
Quiz Question 1

Which magnetic field causes the observed force?

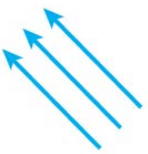




A.



B.



C.

D.

E.

i.e. 32.10:
The magnetic force on an electron

A long wire carries a 10 A current from left to right. An electron 1.0 cm above the wire is traveling to the right at a speed of 1.0×10^7 m/s.

What are the magnitude and the direction of the magnetic force on the electron?

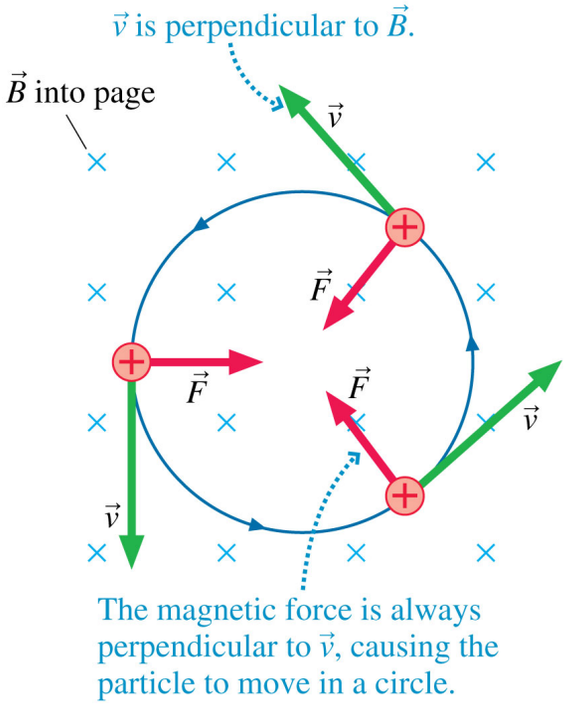
Cyclotron Motion

Consider a charged particle moving perpendicular to a *uniform* *B*-field…

- Since *F* is *perpendicular* to *v*, the charge particle undergoes *uniform circular motion*.

The *radius* of the orbit is…

The *frequency* of revolution is…



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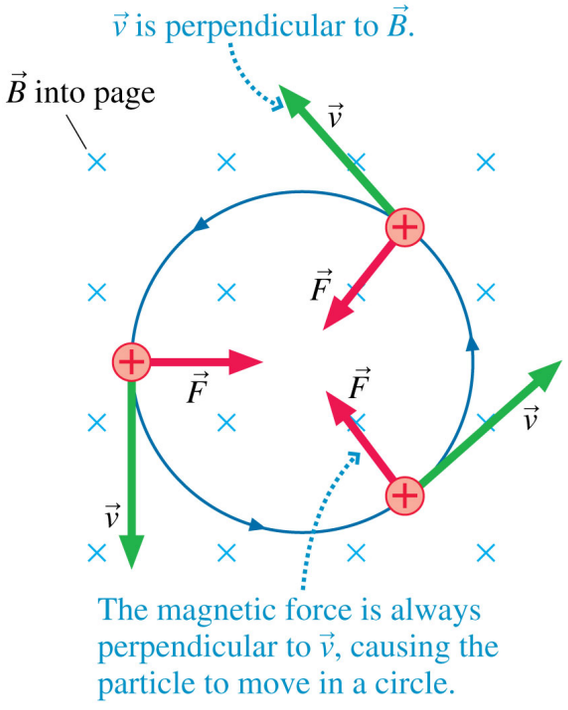


The *radius* of the orbit is…

$$r_{cyc} = \frac{mv}{qB}$$

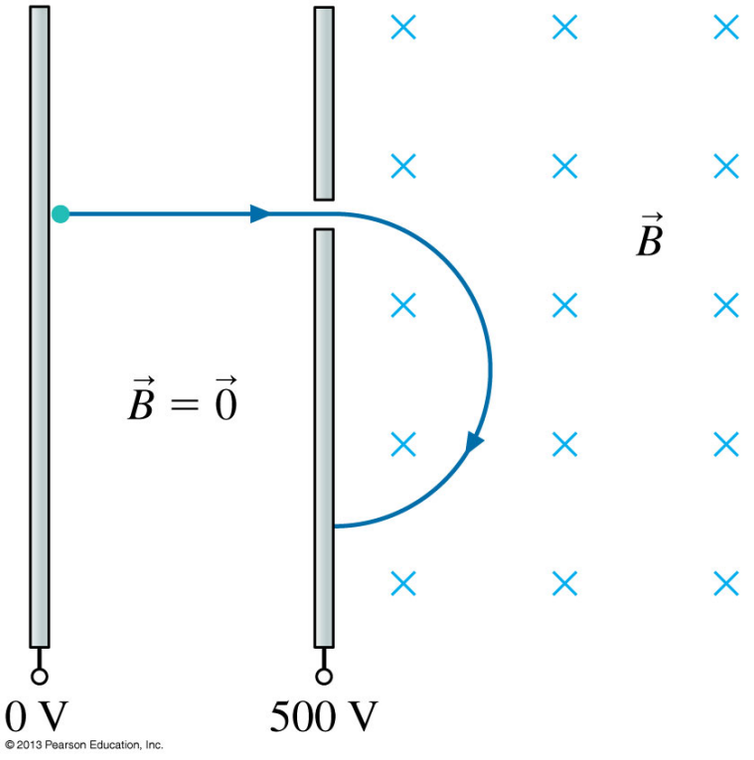
The *frequency* of revolution is…

$$f_{cyc} = \frac{qB}{2\pi m}$$

i.e. 32.11:
The radius of cyclotron motion

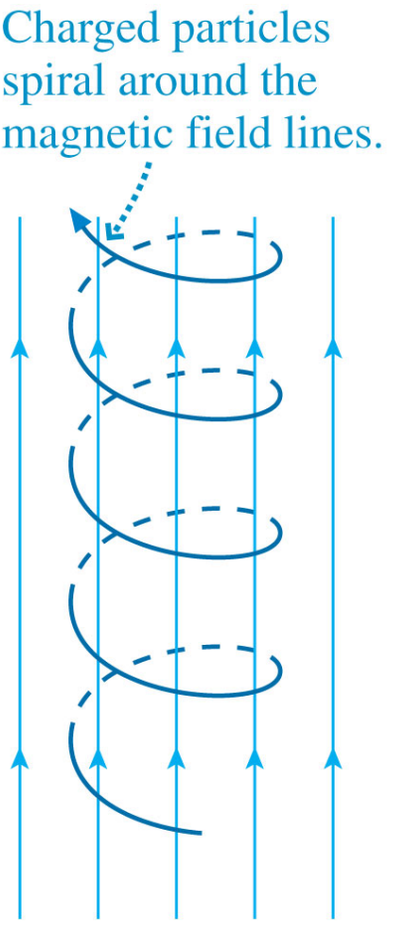
In the figure below, an electron is accelerated from rest through a potential difference of 500 V, then injected into a uniform *B*-field. Once in the *B*-field, it completes half a revolution in 2.0 ns.

What is the *radius* of its orbit?



Cyclotron Motion

What if *v* is NOT *perpendicular* to *B*?

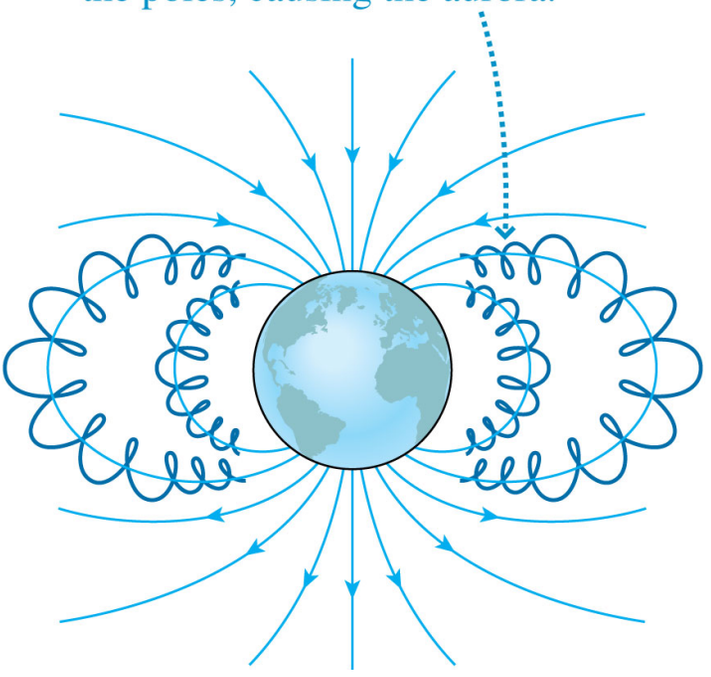


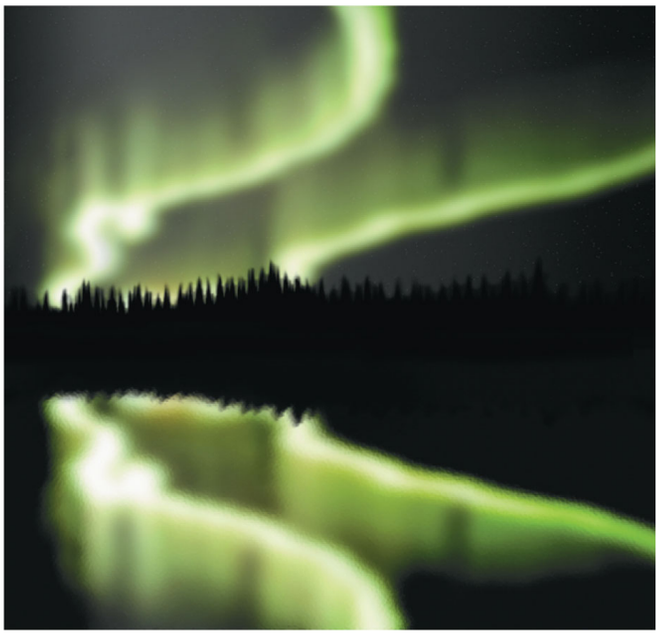
The component of *v parallel* to *B* is NOT affected by the field.

The component of *v perpendicular* to *B* determines the *radius* of the *helix*.

Aurora

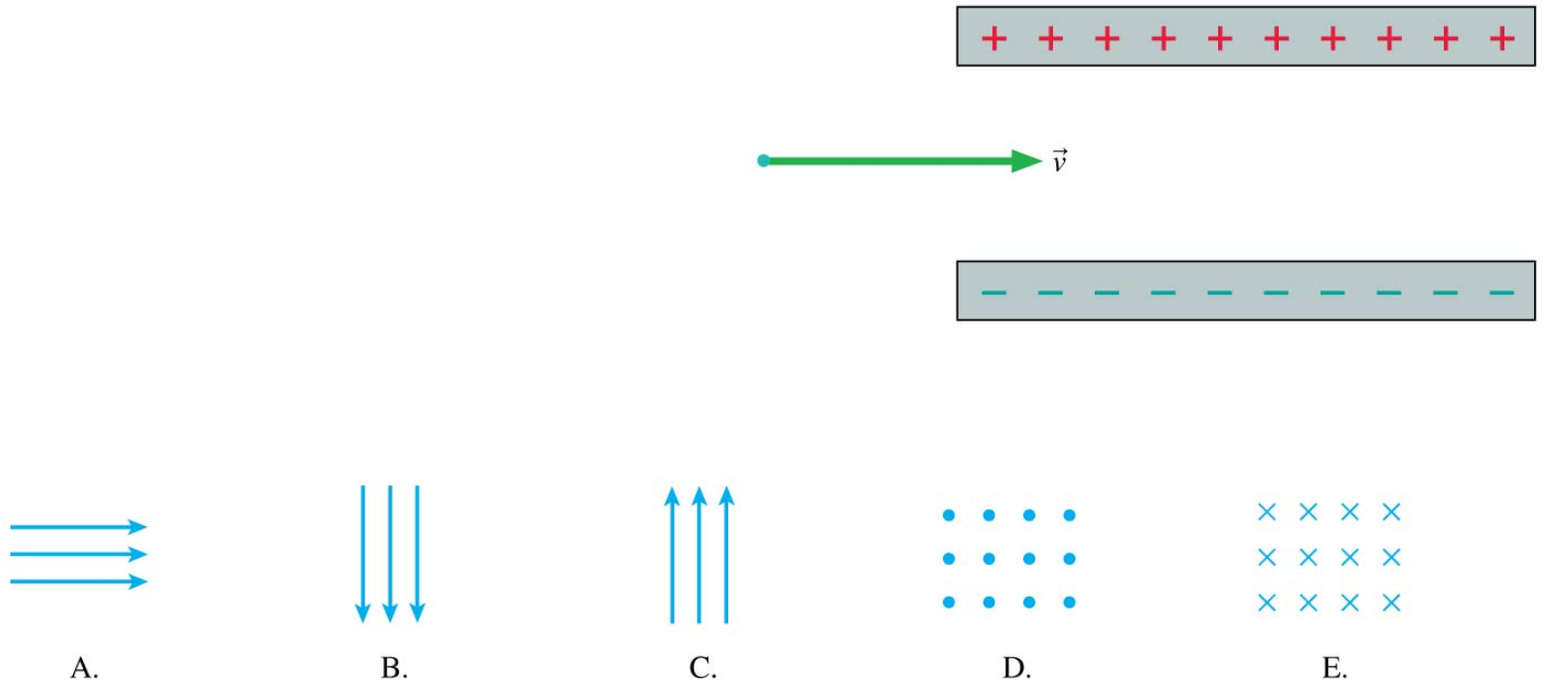
The earth's magnetic field leads particles into the atmosphere near the poles, causing the aurora.





Quiz Question 2

Which *B*-field (if it's the correct strength) allows the electron to pass through the charged electrodes without being deflected?

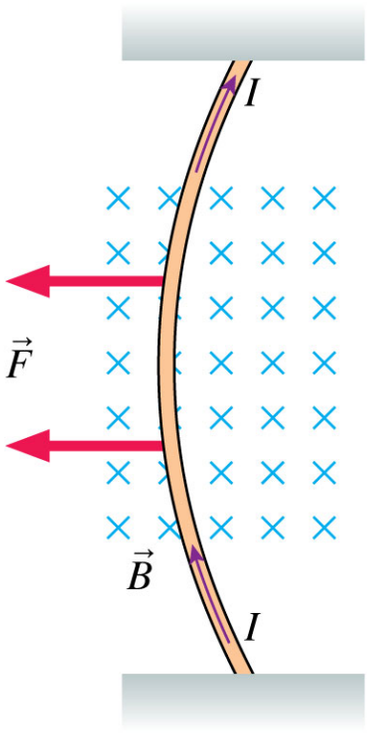


32.8: Magnetic Forces on Current-Carrying Wires

Consider a current-carrying wire *perpendicular* to the *B*-field…

Each charge in the current has a force of magnitude *qvB* directed to the left.

What is the force on the wire?



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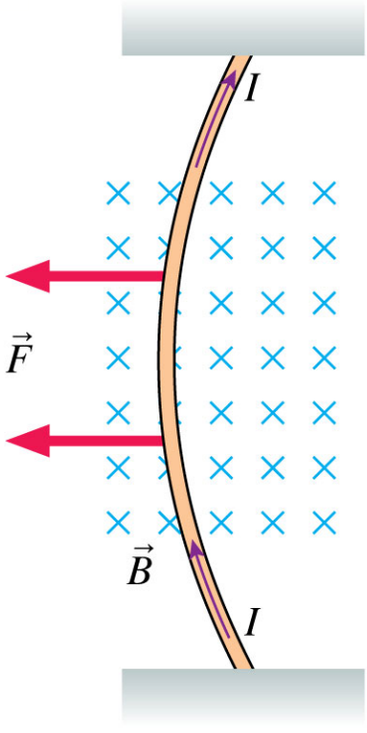
$$\vec{F}_{wire} = I\vec{\ell} \times \vec{B}$$



Magnitude:

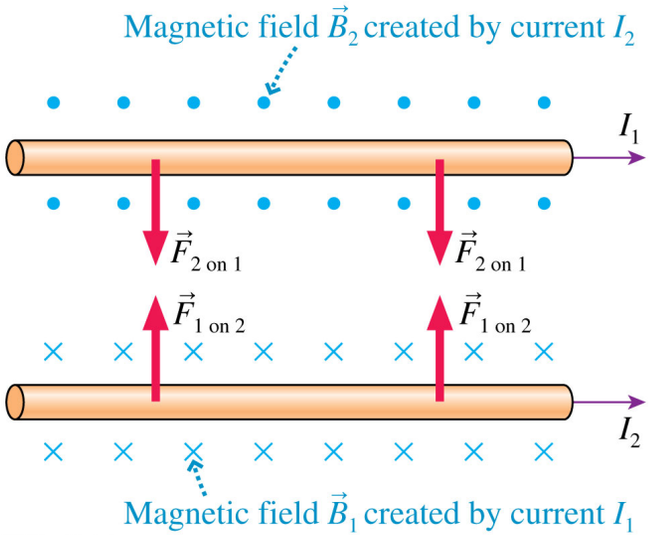
$$F_{wire} = I\ell B \sin\alpha$$

Direction:

RHR

Force Between Two Parallel Wires

What is the force on wire$_1$ due to wire$_2$?



Force Between Two Parallel Wires

What is the force on wire$_1$ due to wire$_2$?

$$F_{1\ on\ 2} = F_{2\ on\ 1} = \frac{\mu_0 \ell I_1 I_2}{2\pi d}$$